

Resource Selection by Translocated Three-Toed Box Turtles in Missouri

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ABSTRACT Resource selection is a multi-staged process of behavioral responses to various resource cues or stimuli. Previous research suggests some aspects of resource selection may be inherent (i.e., genetic predisposition) or based on early experience and that individuals respond to certain resource cues but not to others. In other words, resource selection may be based on a template that specifies which cues to use in the resource-selection process and the appropriate response to those cues. We used resource utilization functions (RUFs) to examine the resource-selection template of translocated three-toed box turtles (*Terrapene carolina triunguis*; hereafter turtles) and made comparisons to resident turtles. Translocated turtles, previously residents of a predominantly forested landscape with low edge-density, used forest openings, forest edges, and southwest-facing slopes before and after translocation to a fragmented site containing resident turtles. In contrast, resident turtles used forested areas and northeast-facing slopes within a predominantly open landscape with high edge-density. Our comparison of resource selection by translocated and resident turtles revealed population-specific resource selection and consistency in selection following translocation, which reinforces the idea of a resource-selection template and suggests that in the short-term box turtles may not adapt their predisposed behavior to local conditions. Thus, translocated animals may evaluate and respond to resource cues as if they were at the original site. Lack of site fidelity may result from individuals seeking additional resources to match their resource-selection template. Successful translocation of turtles may require an assessment of resource selection prior to translocation and development of management strategies that mitigate turtle response to translocation. (JOURNAL OF WILDLIFE MANAGEMENT 72(1):268–275; 2008)

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Resource selection is a hierarchical process of behavioral responses to habitat structure, other individuals, environmental conditions, and the distribution or quality of resources (Hutto 1985, Block and Brennan 1993, Morrison et al. 2006). Hilden (1965) considered resource selection a 2-staged process; the first stage consisted of proximate factors (e.g., resource cues or stimuli) that provided the potential for a settling reaction, and the second stage occurred when combined effects of those factors exceeded a settlement threshold. Under Hilden's (1965) framework, whether an animal settles or selects a resource depends on resource cues and an individual's response to cues.

Wiens (1970) suggested that some aspects of resource selection may be inherent (i.e., genetic predisposition) or based on early experience and that individuals respond to certain resource cues but not to others. In other words, resource selection may be based on a template that specifies which cues to use in the resource-selection process and the appropriate response to those cues. In addition, long-lived species or species with high site fidelity may also develop knowledge of the spatial location of resources (i.e., mental map), which may be used in combination with the resource-selection template to guide resource selection in familiar territory (sensu Caldwell and Nams 2006). Identification of

the resource cues used by animals and mechanisms for evaluating cues at different spatial scales is an important step towards understanding the resource-selection process of any wildlife species. The information gained may improve efforts to increase or maintain habitat conditions for species of management or conservation concern.

One approach to studying mechanisms of resource selection is translocation of individual animals. Translocation enables confirmation of resource-selection patterns because individuals are released in a novel environment and do not possess knowledge of the spatial distribution of resources. In this way, translocation may remove or reduce potential confounding factors common to many resource-selection studies, namely the mental map developed from experience with a particular spatial location. Therefore, translocated individuals may rely solely on resource cues to locate or acquire necessary resources. Resource cues include specific features of the landscape or habitat that provide micro- and macrohabitat conditions, such as food, water, or cover, as well as other animals (Hilden 1965).

We translocated three-toed box turtles (*Terrapene carolina triunguis*), a subspecies of the Eastern box turtle (*T. c. carolina*), to examine resource selection and make comparisons to resident three-toed box turtles. Three-toed box turtles are more edge-tolerant than Eastern box turtles and are found in both open (e.g., old field and early successional)

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and forested habitats (Reagan 1974, Schwartz and Schwartz 1974). Although a common species, several long-term studies of box turtle populations have documented population declines over periods of 20–50 years (Stickel 1978, Schwartz et al. 1984, Williams and Parker 1987, Hall et al. 1999). Causes of turtle population decline vary but may include habitat change (Stickel 1978), collection for pet trade or human consumption (Ceballos and Fitzgerald 2004), disease (Brown et al. 1994, Seigel et al. 2003), and road mortality (Gibbs and Shriver 2002). Continued population declines may result in future translocations of box turtles for reintroduction, mitigation, or maintenance of genetic diversity, similar to those undertaken for gopher tortoises (*Gopherus polyphemus*; Heise and Epperson 2005, Tuberville et al. 2005). Knowledge of resource selection by translocated and resident box turtles may enhance future conservation efforts.

We translocated adult three-toed box turtles (hereafter turtles) from a site with continuous forest cover to a highly fragmented, primarily open site containing a resident turtle population. Our objective was to examine the resource-selection template of three-toed box turtles. We expected that translocated turtles would use the forested habitats at the release site. Alternatively, translocated turtles might use both the open and forested habitat, similar to resident turtles.

STUDY AREA

We studied resource selection by three-toed box turtles at 2 sites, Thomas S. Baskett Wildlife Research and Education Center (hereafter Baskett) located in Boone County, Missouri, USA, which contained the source population for translocated turtles, and Prairie Fork Conservation Area (hereafter Prairie Fork) in Callaway County, Missouri, which had a resident turtle population and served as the release site for translocated turtles.

The study areas differed in historic land cover, land-use history, contemporary management practices, and the amount of forest cover. Baskett lay at the northern boundary of the Outer Ozark Border Subsection, a narrow band of deeply dissected hills and bluffs along the Missouri River (Nigh and Schroeder 2002). The historic land cover at Baskett was dense forests of oak and mixed-hardwood species with prairie openings on flat upland areas. Baskett was a collection of farms in the early 20th century; however, the state acquired the 890-ha area in 1938 and it remained largely undisturbed since that time. During our study approximately 93% of Baskett was second-growth forest, consisting primarily of an oak (*Quercus* spp.) and hickory (*Carya* spp.) overstory and maple (*Acer* spp.) understory. Groundcover in canopy gaps contained blackberries (*Rubus* spp.), *Lespedeza* spp., river oats (*Chasmanthium latifolium*), and other sedges. Former agricultural areas and powerline corridors were maintained as old field habitat by periodic mowing and prescribed burns.

Prairie Fork was a highly fragmented site located approximately 35 km east-northeast of Baskett. Prairie Fork lay at the southern boundary of the Claypan Till Plains Subsection, a glacial till plain marking the southern extent

of glaciation in central Missouri (Nigh and Schroeder 2002). The historic land cover at Prairie Fork was tallgrass prairie, which was converted to cropland and pasture. Since 1996 extensive restoration efforts have restored approximately 68% of the 290-ha area into old field and native prairie. Old field habitat contained warm- and cool-season grasses, wild plum (*Prunus* spp.), blackberries, ragweed (*Ambrosia* spp.), partridge pea (*Chamaecrista nictitans*), and native prairie contained big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and Indiangrass (*Sorghastrum nutans*). The remaining land contained oak, hickory, and early successional woodland. An extensive network of mowed trails supported the educational, recreational, and research-oriented activities on Prairie Fork.

METHODS

Radiotracking and Experimental Design

We captured adult three-toed box turtles (carapace length ≥ 115 mm) during systematic searches and opportunistically at Baskett (4 to 11 May 2002) and Prairie Fork (5 to 30 May 2002). We individually marked all captured turtles ($n = 128$ at Baskett; $n = 103$ at Prairie Fork) by filing marginal scutes (Cagle 1939, Schwartz and Schwartz 1974). We attached R2020 reptile glue-on transmitters (Advanced Telemetry Systems, Inc., Isanti, MN) using quick-set epoxy to 20 turtles at Baskett and 23 turtles at Prairie Fork. We distributed transmitters approximately equally between sexes. We attached transmitters to the third pleural scute on the posterior of the carapace. Transmitter position minimized the increase in carapace height or width and reduced interference with breeding activities. Transmitter mass (12.5 g) plus epoxy totaled < 25 g and constituted 3–5% of turtle mass. A previous study found no effect of transmitter attachment on fecal glucocorticoid metabolite (i.e., stress) levels (Rittenhouse et al. 2005).

We relocated turtles once every 28 hours (± 3 hr) using homing methods (Mech 1983), confirmed by visual observation, and recorded Universal Transverse Mercator (UTM) coordinates of turtles using hand-held Global Positioning System (GPS) units (approx. 3-m accuracy). We estimated UTM coordinates using the GPS when we did not obtain visual observation (e.g., turtle located beneath brush or under downfall). We assumed the telemetry error for nonvisual locations was less than error associated with the hand-held GPS.

We conducted an experimental translocation to compare resource selection by turtles before and after translocation as well as to resident turtles (Rittenhouse et al. 2007). We radiotracked turtles at both sites from 14 May to 28 June 2002 (period 1). From 28 June to 30 June 2002, we captured and transported the Baskett turtles to Prairie Fork. We released Baskett turtles at 2 areas within Prairie Fork. Each release area contained 4 release sites arranged in a 2×2 block with 2 forested and 2 open sites per release area. We randomly assigned turtles to release sites and used a compass to determine a random corner (e.g., northwest, northeast, southeast, or southwest) within each release site

Table 1. A priori models for three-toed box turtle resource utilization functions at the Thomas S. Baskett Wildlife Research and Education Center and the Prairie Fork Conservation Area, Missouri, USA, summer 2002.

Hypothesis	Model structure ^a
1. Microclimate	$\beta_0 + \beta_1(\text{aspect}) + \beta_2(\text{slope})$
2. Forest and edge	$\beta_0 + \beta_1(\text{ppn_decid}) + \beta_2(\text{edgeden})$
3. Forest and edge microclimate	$\beta_0 + \beta_1(\text{ppn_decid}) + \beta_2(\text{edgeden}) + \beta_3(\text{aspect}) + \beta_4(\text{slope})$
4. Water and habitat type	$\beta_0 + \beta_1(\text{distwater}) + \beta_2(\text{open}) + \beta_3(\text{decid})$
5. Global	$\beta_0 + \beta_1(\text{ppn_decid}) + \beta_2(\text{edgeden}) + \beta_3(\text{aspect}) + \beta_4(\text{slope}) + \beta_5(\text{distwater}) + \beta_6(\text{open}) + \beta_7(\text{decid})$

^a Aspect = sine transformed aspect; slope = % slope; ppn_decid = proportion of deciduous forest within a 12-ha moving window; edgeden = density of edge (m) within a 12-ha moving window; distwater = distance from center of cell to nearest water (m). We coded habitat type using 2 dummy variables: open = old field or restored prairie, and decid = deciduous forest. We included coniferous forest and water in the intercept.

for the actual release location (Rittenhouse et al. 2007). We also randomized each turtle's orientation at release. We relocated Baskett (translocated) and Prairie Fork (resident) turtles on Prairie Fork from 30 June to 12 August 2002 (period 2). We returned translocated turtles to Baskett and removed all transmitters at the completion of the study. The University of Missouri Animal Care and Use Committee approved our research (Protocol 3629).

Defining the Resource Utilization Function

We used the Marzluff et al. (2004) resource utilization function (RUF) approach to relate turtle utilization distributions (UD) to resource attributes using multiple regression adjusted for spatial autocorrelation. Resource utilization functions differ from resource selection functions (RSFs; Manly et al. 2002) by considering use as continuous rather than discrete (i.e., used or not used) and by estimating real probabilities rather than proportional probabilities as logistic regression does. Thus, RUFs may be viewed as an extension of RSFs (Marzluff et al. 2004). We included all turtles with ≥ 30 locations per period in the RUF analysis to meet sample size requirements for kernel density estimation (Kernohan et al. 2001). We calculated 95% fixed kernel density estimates for each Baskett and Prairie Fork turtle for each period using the Kde folder of MATLAB (Mathworks, Inc., Natick, MA), which provided kernel density estimates throughout each turtles' utilization distribution (Beardah and Baxter 1995). We used the plug-in option for bandwidth selection (Wand and Jones 1995, Jones et al. 1996, Gitzen et al. 2006) and excluded the outer 5% of the UD (by vol) to reduce potential bias from extremely low use areas on the tails of the UD.

We over-laid individual utilization distribution grids on Geographic Information System (GIS) layers for each study area within ArcView 3.3. We derived slope and aspect from a digital elevation model with 10-m resolution, resampled to 5-m resolution, and quantified additional resource attributes associated with each 5×5 -m pixel within the UD boundary (Table 1). We used the height of a turtle's utilization distribution at each pixel as the response variable in the multiple-regression analysis (Marzluff et al. 2004, Millspaugh et al. 2006).

Model Development

We used an information-theoretic approach to model construction and selection (Burnham and Anderson 2002).

We developed a Global model (model 5) that included all resource variables and assessed the goodness-of-fit of the Global model using a likelihood-ratio test. From the Global model, we developed 4 candidate models of turtle resource selection (Table 1) and fit all candidate models including the Global model to each turtle for each period. The first model, Microclimate, contained 2 factors associated with favorable microclimate conditions for turtle thermoregulation, aspect and slope. We predicted turtles would use north and northeast aspects as thermal refugia and south aspects as basking sites (Hallgren-Scaffidi 1986). We transformed aspect (in radians) using:

$$\sin(\text{aspect} + 0.78539) + 1, \quad (1)$$

that yielded values that ranged from 0 (at 225° , or SW) to 2 (at 45° , or NE). Williams and Parker (1987) had fewer captures in areas with steep slopes, possibly because slopes impede turtle movement. Thus, we predicted turtles would use gentler slopes.

The Forest and Edge model contained factors associated with forest habitat and edges (Table 1). Based on research conducted in forested lowland and upland habitat during the summer, we predicted turtles would use forested habitats more than open habitats (Stickel 1950, Reagan 1974, Schwartz and Schwartz 1974). We quantified the proportion of deciduous forest cover and forest edge-density within a 40-pixel moving window (pixel size = 5 m; total window size = 12.6 ha). The area of the moving window corresponded to the average home-range size of three-toed box turtles at the 2 study sites (Rittenhouse et al. 2007). The Forest and Edge Microclimate model addressed forest and forest edge microclimate conditions and contained the 4 variables from the Microclimate and Forest and Edges models (Table 1).

The Water and Habitat Type model contained distance to water and habitat type variables (Table 1). Rossell et al. (2006) associated box turtle microhabitat selection with thermoregulation and minimizing water loss. Box turtles will move towards and use temporary ponds during periods of high temperatures and low precipitation, presumably to mitigate water loss (Donaldson and Echternacht 2005). We calculated distance to water from the center of a cell to the nearest permanent or ephemeral water source.

We partitioned habitat type into open or deciduous forest to facilitate examination of resource use by individuals. Schwartz and Schwartz (1974) and Williams and Parker

Table 2. Number of times each model of three-toed box turtle resource utilization functions received the most support at Thomas S. Baskett Wildlife Research and Education Center (Baskett) and the Prairie Fork Conservation Area (Prairie Fork), Missouri, USA, for period 1 (14 May to 28 Jun 2002) and period 2 (30 Jun to 12 Aug 2002). We translocated Baskett turtles to Prairie Fork from 28 June to 30 June 2002.

Model	Baskett						Prairie Fork					
	Period 1			Period 2			Period 1			Period 2		
	No. times	Akaike wt		No. times	Akaike wt		No. times	Akaike wt		No. times	Akaike wt	
		\bar{x}	Range		\bar{x}	Range		\bar{x}	Range		\bar{x}	Range
Microclimate	2	0.69	0.64–0.74	0			0			1	0.68	
Forest and edge	2	0.76	0.54–0.98	4	0.58	0.46–0.73	2	0.62	0.49–0.75	0		
Forest and edge microclimate	3	0.64	0.52–0.80	2	0.80	0.71–0.88	3	0.62	0.48–0.79	1	0.63	
Water and habitat type	1	0.46		1	0.51		1	0.32		0		
Global	4	0.99	0.95–1.00	5	0.88	0.64–1.00	8	0.92	0.49–1.00	12	0.89	0.34–1.00

(1987) reported increased captures in old field habitat undergoing succession, and Madden (1975) concluded that box turtles favor forest–brush and forest–field ecotones. We used 2 dummy variables for habitat type of each pixel within the utilization distributions: open habitat included old fields, prairie restoration sites, and grasslands, and forest habitat included deciduous forest. We included the remaining habitats, coniferous forest and water, in the intercept term. We modified the habitat type variables for individual turtles that used only open or deciduous forest habitat by using a single dummy variable (open or forested) and included the remaining habitat in the intercept term.

Model Selection

We conducted the resource utilization function analyses in program R (Ihaka and Gentleman 1996) using the `ruf.fit` function from the RUF library (Marzluff et al. 2004). We used the height of the UD for each pixel within a turtle's utilization distribution as the response variable and the resource attributes of the same pixel (described above) as the independent variables in the multiple regression analysis. The `ruf.fit` function used a stationary model from the Matern class to account for spatial autocorrelation (Handcock and Stein 1993, Marzluff et al. 2004). We used Akaike's Information Criterion (AIC) to determine the best approximating model from the candidate model set, ranked candidate models using ΔAIC , and determined the relative likelihood of a model, given the data and set of models for each turtle, using Akaike weights (Burnham and Anderson 2002).

We examined the standardized RUF coefficients ($\hat{\beta}_j$) from the most supported model for each turtle to compare use of specific resources by turtle origin (Baskett or Prairie Fork) and period (period 1 or period 2). In addition, we estimated a population-level RUF for each turtle origin-by-period combination by taking the average of the standardized RUF coefficients from the most supported model for each individual using

$$\hat{\bar{\beta}}_j = \frac{1}{n} \sum_{i=1}^n \hat{\beta}_{ij}, \quad (2)$$

where $\hat{\beta}_{ij}$ was the estimate of coefficient j for individual i . This process produced 4 population-level RUFs (e.g.,

Baskett period 1, Baskett period 2, Prairie Fork period 1, and Prairie Fork period 2). We obtained a conservative estimate of variance for the population-level model coefficients using

$$\text{Var}(\hat{\bar{\beta}}_j) = \frac{1}{n-1} \sum_{i=1}^n (\hat{\beta}_{ij} - \hat{\bar{\beta}}_j)^2, \quad (3)$$

which included both intra-turtle and inter-turtle variation (Marzluff et al. 2004). The magnitude of the standardized $\hat{\bar{\beta}}_j$ indicated the relative importance of specific resources and the sign indicated the direction of use. We also summarized the resource attributes within turtle utilization distributions using box-and-whisker plots.

RESULTS

We had sufficient relocations (≥ 30 /turtle/period) to estimate RUFs for 12 Baskett turtles and 14 Prairie Fork turtles during both periods. The most supported RUFs for each turtle based on Akaike weights varied among turtles, but the Global model received the most support in 29 of the 52 (55.8%) turtle-by-period sets of models (Table 2). The Forest and Edge Microclimate model received the most support in 9 sets of models (17.3%), followed by the Forest and Edge model (8 sets of models, 15.4%). The remaining 2 models, Microclimate and Water and Habitat Type, received support in only 3 sets of models (5.7%). Besides the Global model, we observed the most support for the Forest and Edge Microclimate model in period 1 (3 of 12 models, 25.0%) and the Forest and Edge model in period 2 for Baskett turtles (4 of 12 models, 33.3%). In contrast, the Microclimate model received the most supported model for only one Prairie Fork turtle (1 of 14 models, 7.1%) and the Forest and Edge model was not the most supported model for any Prairie Fork turtles in period 2 (Table 2).

The population-level RUFs for Baskett turtles differed in magnitude and direction from the population-level RUFs for Prairie Fork turtles prior to and following translocation to Prairie Fork. Prior to translocation (e.g., period 1) Baskett turtles inhabited a predominantly forested landscape with low edge-density (Fig. 1). The population-level RUF for Baskett turtles in period 1 indicated that use decreased as the proportion of deciduous forest increased ($\hat{\bar{\beta}}_{ppn_decid}$ is

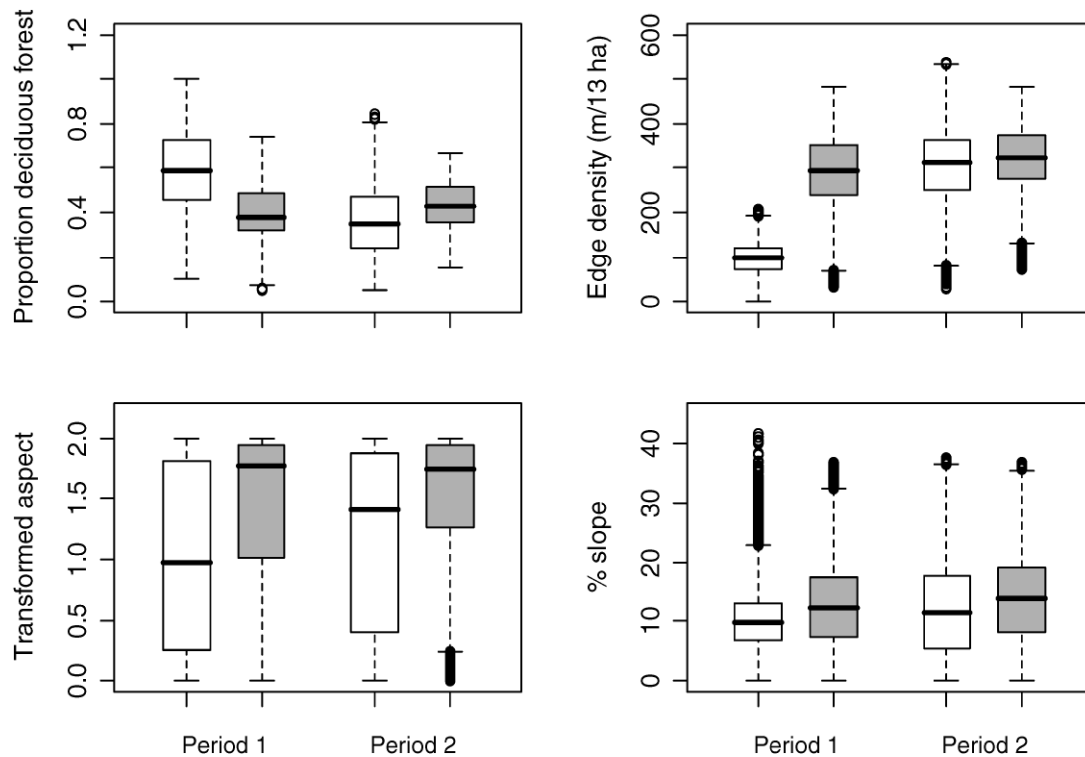


Figure 1. Resource attributes (box-and-whisker plots) within three-toed box turtle utilization distributions at the Thomas S. Baskett Wildlife Research and Education Center (open box) and the Prairie Fork Conservation Area (shaded box), Missouri, USA, for period 1 (14 May to 28 Jun 2002) and period 2 (30 Jun to 12 Aug 2002). We translocated Baskett turtles to Prairie Fork from 28 June to 30 June 2002.

negative; Table 3). Baskett turtles used slopes with a variety of aspects (Fig. 1), but use decreased as aspect increased from the southwest to the northeast ($\hat{\beta}_{aspect}$ is negative; Table 3). Additionally, use increased as edge-density increased ($\hat{\beta}_{edgeden}$ is positive; Table 3).

Following translocation to Prairie Fork (e.g., period 2), Baskett turtles continued to use resources in a similar manner as they had at Baskett, despite being in a predominantly open landscape with high edge-density (Fig. 1). The signs for the population-level standardized coefficients ($\hat{\beta}_j$) in period 2 remained the same with the exception of distance to water; use decreased with increasing distance to water ($\hat{\beta}_{distwater}$ is negative; Table 3). Interest-

ingly, the magnitude of the $\hat{\beta}_j$ for several resource attributes increased greatly, indicating that the use of these resources increased following translocation. The $\hat{\beta}_j$ increased 61-fold for proportion of deciduous forest, 6-fold for edge-density, 68-fold for slope, and 4-fold for distance to water (Table 3).

In contrast to Baskett turtles, the population-level RUFs for Prairie Fork turtles in period 1 and period 2 indicated that use increased as the proportion of deciduous forest increased and edge-density decreased (both $\hat{\beta}_{ppn_decid}$ are positive; Table 3). Prairie Fork turtles used predominantly north-facing slopes (Fig. 1) and use increased from the southwest to the northeast in both periods ($\hat{\beta}_{aspect}$ is positive; Table 3). The magnitude of the $\hat{\beta}_j$ remained similar among

Table 3. Population-level resource utilization functions (RUF) for three-toed box turtles at the Thomas S. Baskett Wildlife Research and Education Center (Baskett) and the Prairie Fork Conservation Area (Prairie Fork), Missouri, USA, for period 1 (14 May to 28 Jun 2002) and period 2 (30 Jun to 12 Aug 2002). We translocated Baskett turtles to Prairie Fork from 28 June to 30 June 2002. We averaged the estimates of standardized coefficients ($\hat{\beta}_j$) from the most-supported model for each turtle by origin and period to obtain the population-level RUFs.

Resource attribute	Baskett				Prairie Fork			
	Period 1		Period 2		Period 1		Period 2	
	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE	\bar{x}	SE
Intercept	87,951.2	41,228.7	95,081.3	57,397.1	-18,934.1	160,857.0	400,113.7	165,110.7
Proportion of deciduous forest	-44.8	366.7	-2,747.8	4,826.1	196.7	227.0	1,543.0	1,536.6
Edge-density (m/12 ha)	787.9	910.0	4,645.8	4,228.6	-2,205.1	1,275.3	-2,535.9	2,202.4
Aspect	-107.8	88.1	-118.9	79.7	126.4	239.4	2,415.4	3,616.3
Slope	60.2	57.7	4,119.0	3,620.8	384.0	336.5	323.4	810.3
Distance to water (m)	430.6	294.0	-1,709.7	1,102.9	3,845.1	5,506.9	-5,318.1	3,071.3
Open habitat	-26.8	7.2	118.9	81.8	-92.6	63.8	401.4	549.5
Forest habitat	-1.4	12.3	129.8	84.9	-125.0	129.2	241.7	190.3

periods with the exception of proportion of deciduous forest (8-fold increase) and aspect (19-fold increase), indicating that the relative use of those 2 resources increased in period 2 (both $\hat{\beta}_{ppn_decid}$ and $\hat{\beta}_{aspect}$ are positive; Table 3). As with the Baskett turtles, use decreased as the distance to water increased in period 2 ($\hat{\beta}_{distwater}$ is negative; Table 3). However, the magnitude of the $\hat{\beta}_j$ remained similar among periods for Prairie Fork turtles (Table 3).

DISCUSSION

Our comparison of resource selection by translocated and resident turtles revealed 2 striking patterns: population-specific resource selection and consistency of selection following translocation. These patterns reinforce the idea of a resource-selection template and support Wiens' (1970) suggestion that individuals may be predisposed to evaluate specific resource cues despite differences in the availability of those cues.

Our results suggest that resource selection by turtles involves an inherent response to specific resource cues based on a resource-selection template. When the realized outcome does not match with the resource-selection template a turtle either remains where it is or moves to a different location. Previous research on translocated box turtles showed that turtles moved and that they moved greater distances per day and had larger home ranges than resident turtles (Rittenhouse et al. 2007). Here we showed that resource selection by translocated turtles remained the same as before translocation. Our study, coupled with Rittenhouse et al. (2007), indicates that translocated turtles were attempting to find a location where the realized outcome, based on the response to resource cues, matched the resource-selection template. Thus, in the short term, box turtles may not adapt their predisposed behavior to local conditions; rather, turtles move to find conditions that match the resource-selection template. Although resource selection by translocated turtles is likely site- and species-specific, the resource selection and movement response may explain the low site-fidelity exhibited by translocated Eastern box turtles (Cook 2004), ornate box turtles (*Terrapene ornata*; Doroff and Keith 1990), and gopher tortoises (Heise and Epperson 2005, Tuberville et al. 2005), as well as the response of Florida box turtles (*T. c. bauri*) to disturbance (Dodd et al. 2006). Understanding long-term consequences of having a resource-selection template that does not match local conditions will require monitoring demographic (i.e., survival and fecundity) and physiological (i.e., chronic stress) responses of box turtles to translocation.

The differences in resource selection among the 2 turtle populations we studied were surprising. Although the 2 study areas differed in the proportion of deciduous forest and edge-density, we expected that both turtle populations would primarily use forested habitat and that use of open habitat would be limited in duration or result from travel between forested areas. Previous studies of three-toed box turtles showed use of mesic forests during the summer and higher densities of turtles in forested areas than in open

areas (Reagan 1974, Schwartz and Schwartz 1974). Baskett turtles, residents of a predominantly forested landscape with low edge-density, used forest openings, forest edges, and southwest-facing slopes. In contrast, Prairie Fork turtles used forested areas and northeast-facing slopes within a predominantly open landscape with high edge-density. Presumably, the use of these resources may facilitate thermoregulation in addition to other needs (e.g., foraging). Similar closed canopy oak-hickory forests in southern Missouri had a more stable climate than open-canopy areas (i.e., clear cuts), including lower daytime temperatures, higher relative humidity, and lower solar radiation (Chen et al. 1997). Baskett turtles may have used forest edges and south-facing aspects to maintain their body temperature above ambient conditions, whereas Prairie Fork turtles may have used forests and north-facing aspects to maintain a body temperature at or below ambient conditions. Rossell et al. (2006) reported no difference in substrate or air temperature between box turtle locations and paired random locations within 25 m of the turtle. Our results indicate that box turtles may thermoregulate by use of habitat type and aspect in addition to specific locations within habitat types (e.g., microclimate) as in Rossell et al. (2006).

Although we documented population-specific resource selection for the majority of resources examined, some resources may be so important that the elicited response is the same across populations. For example, the relationship with water was similar for both turtle populations. We conducted our study from early May to early August, a period of increasing daily high temperatures and low precipitation. Baskett and Prairie Fork turtles increased use of areas within their utilization distribution that were closer to water sources, as indicated by the change in sign of the population-level standardized RUF coefficients for distance to water from period 1 to period 2 (Table 3). Previous studies have reported box turtles adjacent to or resting in water sources during periods of high temperatures (Hurter 1911, Overton 1916, Stickel 1950, Donaldson and Echternacht 2005). The consistency of selection for water suggests that the response to this particular habitat cue may be similar for all box turtle populations.

MANAGEMENT IMPLICATIONS

Wildlife managers and biologists use translocations to augment existing populations and to create new ones, typically where populations have been extirpated (i.e., repatriation). Translocation of turtles or tortoises is often undertaken with little choice of release sites and the ability to quantify resources at both the source and release sites may be limited. Our study suggests there may be inherent differences in resource-selection templates among populations of the same species. An individual animal's resource-selection template may be static (either based on experience or hard-wired by locality), at least for the short term, which means that translocated animals may evaluate and respond to resource cues as if they were at the original site. Thus, we should consider not only the resources at the release site, but

also the resources at the source site when planning for translocations. If the sites differ in resource composition, distribution, or abundance, individuals released at the new site may have an inappropriate response to resource cues. Lack of site fidelity may result from individuals seeking additional resources to match their resource-selection template. In other words, individuals may continue searching for habitat that will match the anticipated outcome. Additional research regarding long-term response of turtles to translocation as well as management strategies to mitigate their response, such as penning to increase acclimation time or providing supplemental water during captivity, is needed to further evaluate translocation as a management tool for turtle conservation (Tuberville et al. 2005, Field et al. 2007).

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